

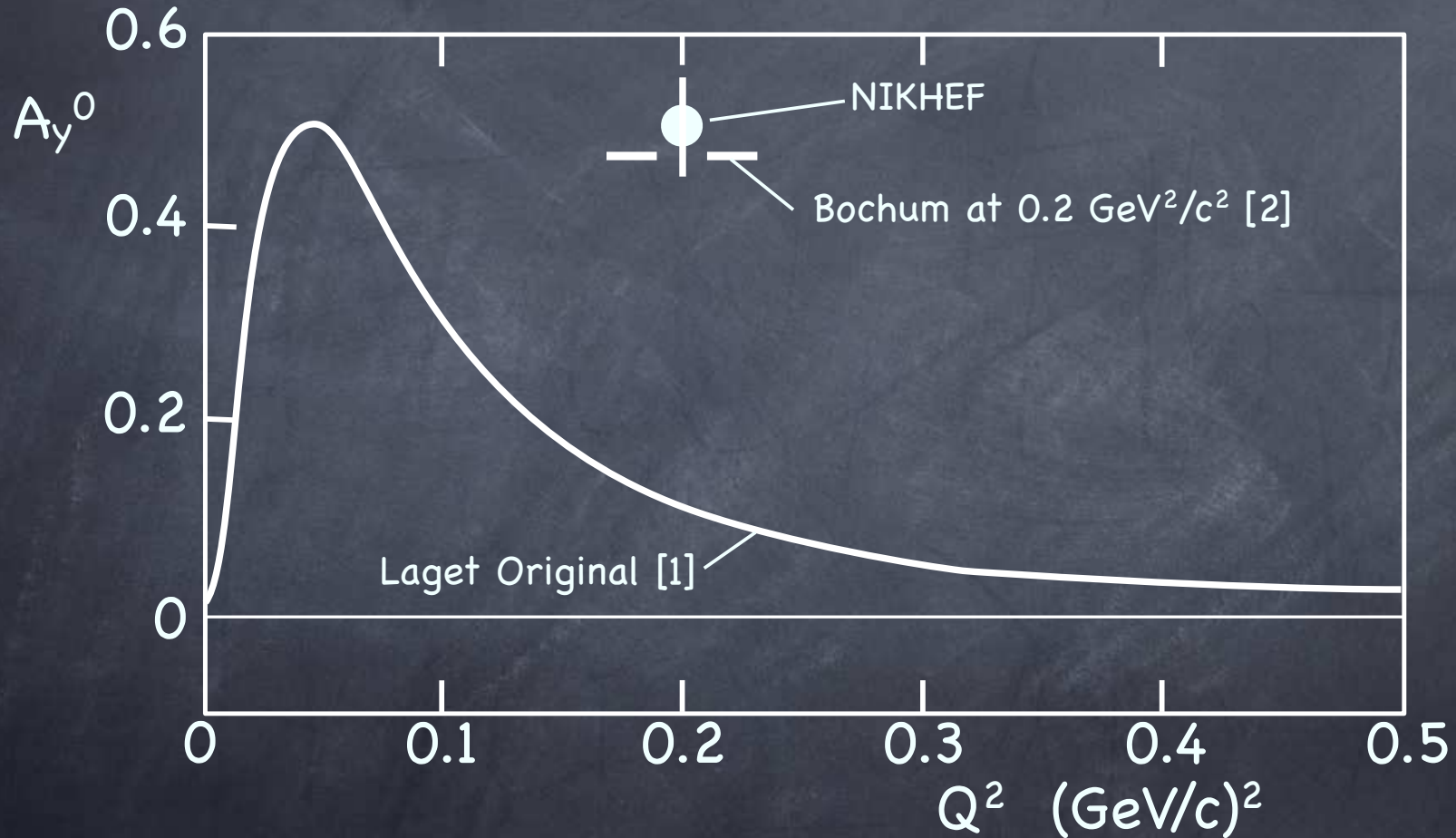
A_y Measurement from ${}^3\text{He}^\uparrow(e,e'n)$ Scattering at Jefferson Lab

Elena Long
APS "April" Meeting
February 15th, 2010

$A_y: {}^3\text{He}^\uparrow(e,e'n)$

- In PWIA, A_y in Quasi-Elastic ${}^3\text{He}^\uparrow(e,e'n)$ is exactly zero
- Previous experiment at NIKHEF measured A_y at $0.2 [\text{GeV}/c]^2$
- Faddeev calculations by Bochum group correctly predicted large FSI where other groups expected a much lower value

$A_y: {}^3\text{He}^\uparrow(e, e'n)$



[1] J. M. Laget, Phys. Lett. B273, 367 (1991).

[2] W. Gloeckle, H. Witala, D. Huber, H. Kamada, and J. Golak, Phys. Rept. 274, 107 (1996).

$A_y: {}^3\text{He}^\uparrow(e, e'n)$

- Previous to this experiment, no measurements of A_y have been done at large Q^2
- We will analyze high precision data points taken at $0.1 [\text{GeV}/c]^2$, $0.5 [\text{GeV}/c]^2$, and $1.0 [\text{GeV}/c]^2$

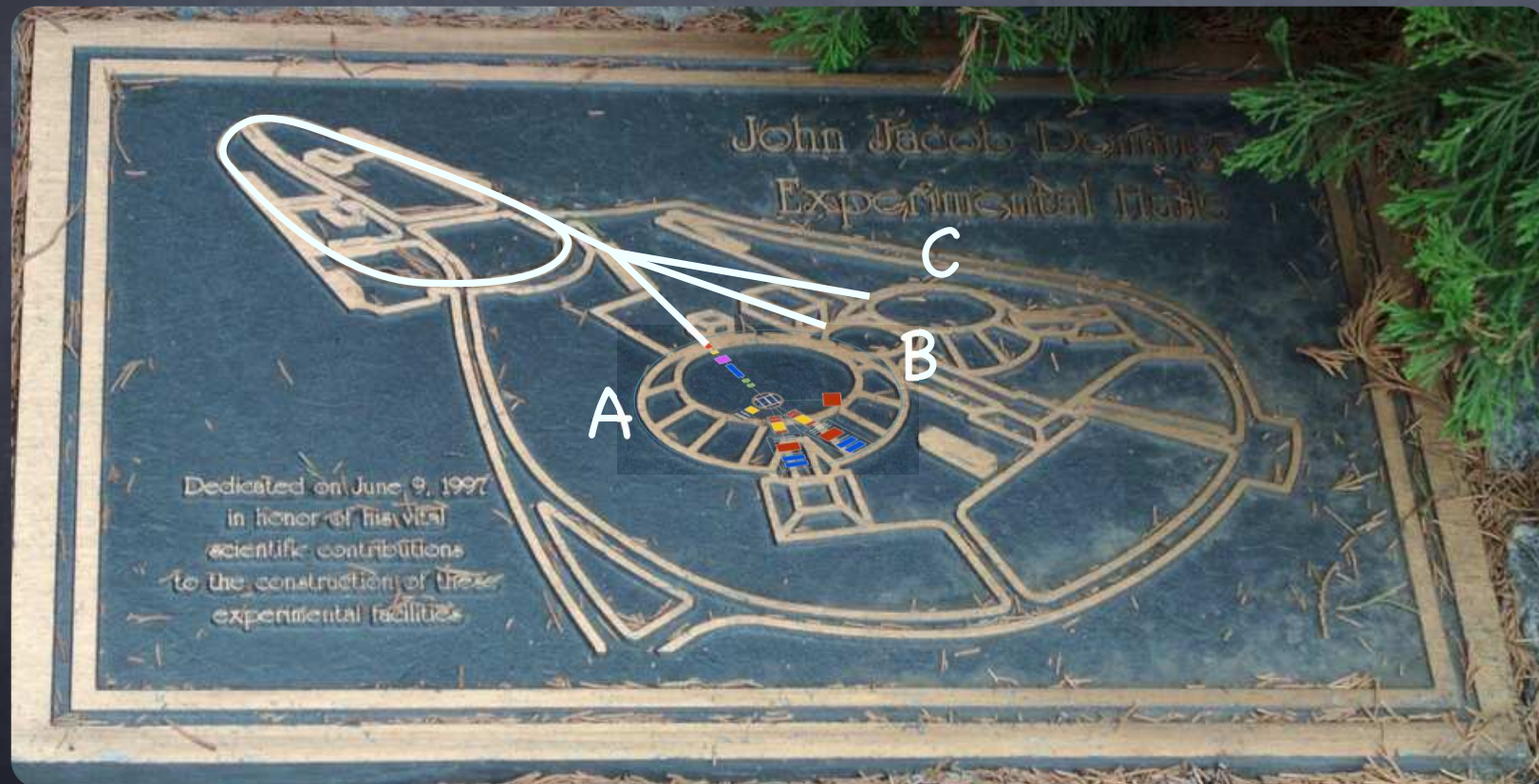
$A_y: {}^3\text{He}^\uparrow(e, e'n)$

- Data will test state of the art calculations at high Q^2
 - Neutron form factor extractions must correctly predict this asymmetry
 - In calculating G_E^n from ${}^3\overline{\text{He}}(\vec{e}, e'n)$, A_y from ${}^3\text{He}^\uparrow(e, e'n)$ will also be calculated
- At high Q^2 , any non-zero result is indicative of effects beyond impulse approximation

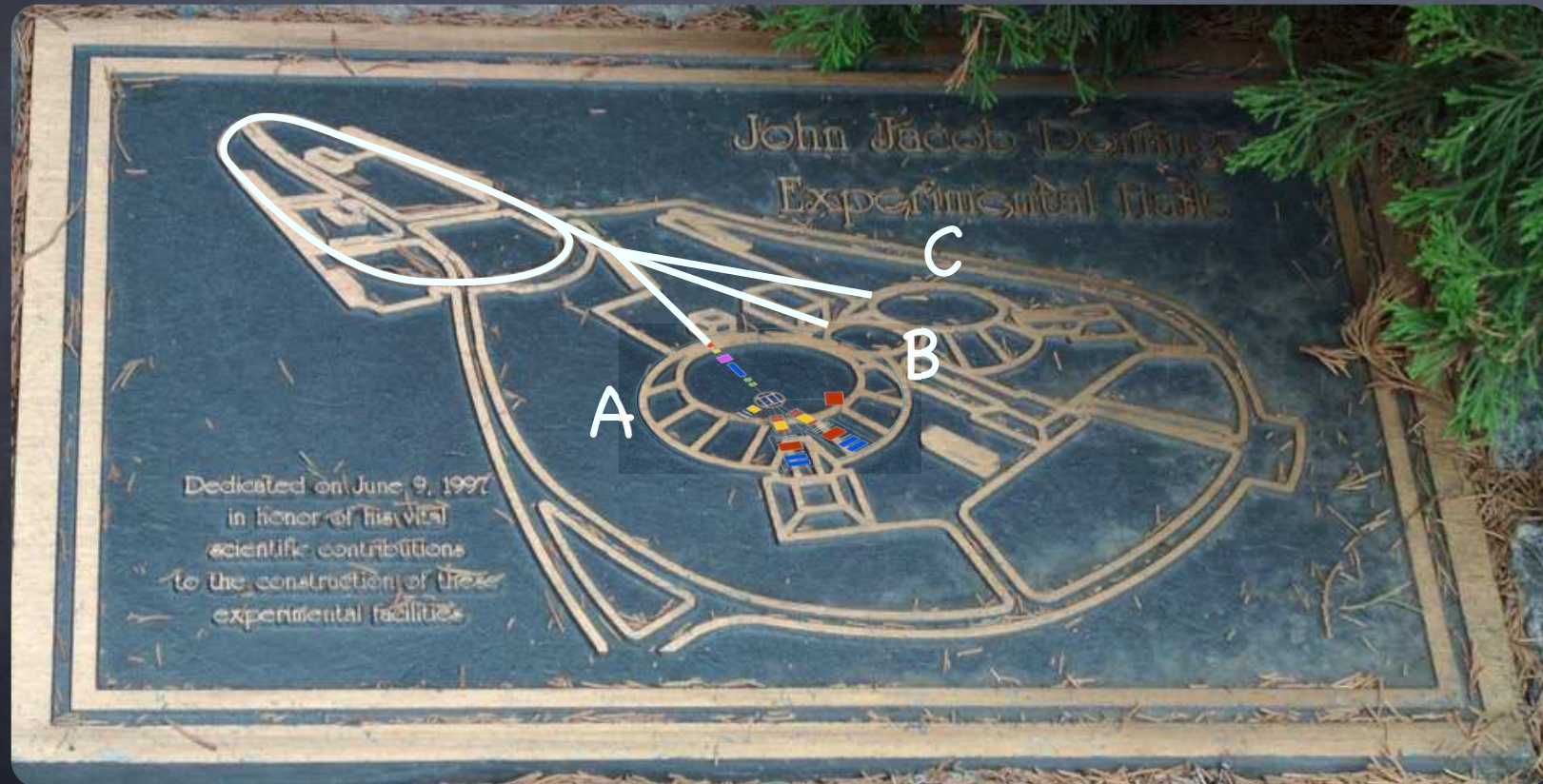
Jefferson Lab



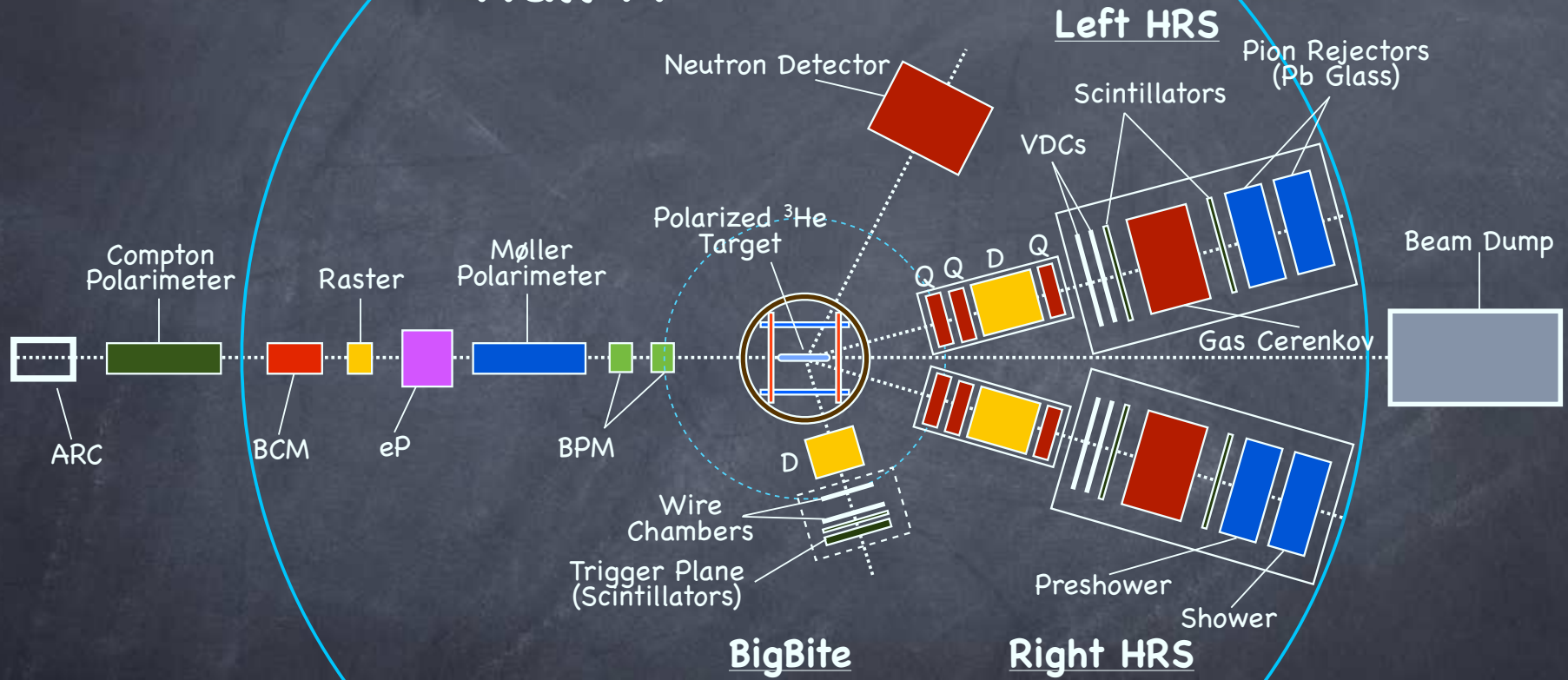
Jefferson Lab



Jefferson Lab

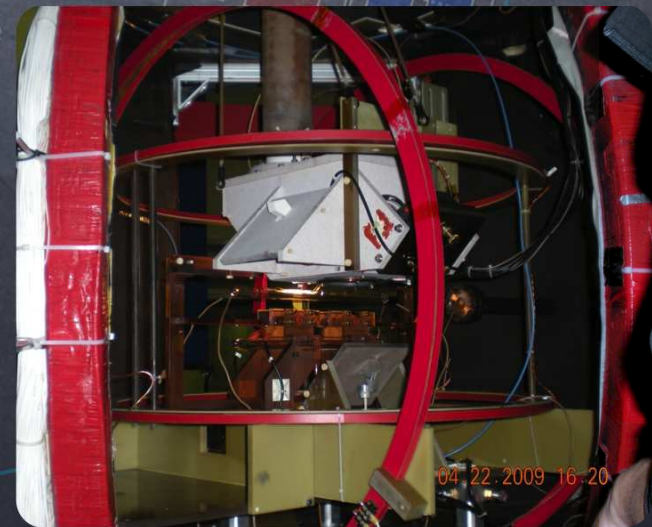
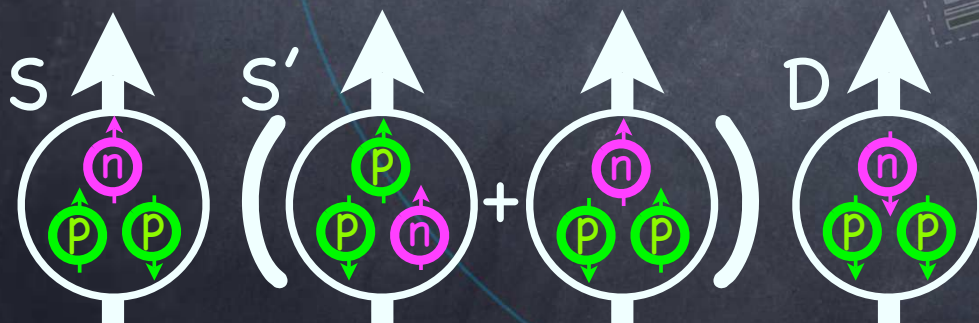
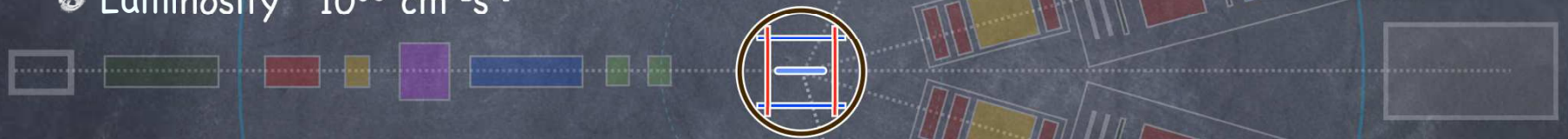


Hall A



Polarized ^3He Target

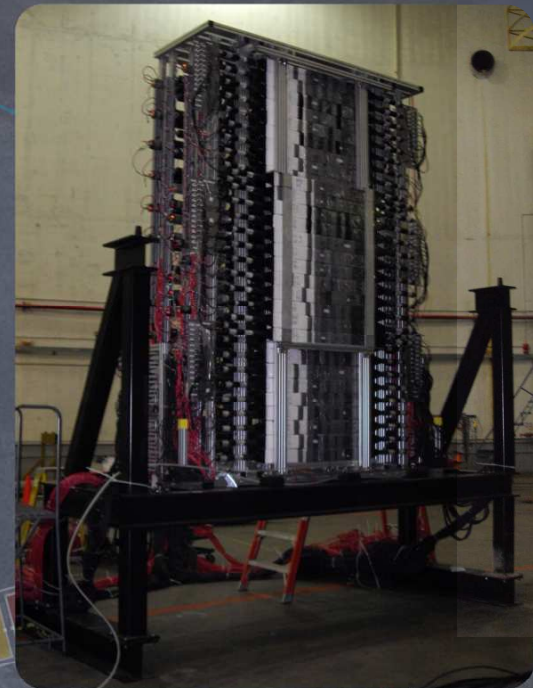
- Optically Pumped Rubidium Vapor used with Potassium to Polarize ^3He via Spin Exchange
- NMR and EPR Measure Polarization
- Polarization was in Vertical Direction
- Can Polarize up to 60%
- Luminosity $\sim 10^{36} \text{ cm}^{-2}\text{s}^{-1}$



04.22.2009 16:20

Hall A Neutron Detector

- Detects neutrons from ${}^3\text{He}(e,e'n)$
- Along with RHRS allows G_E^n and A_y measurements to be made

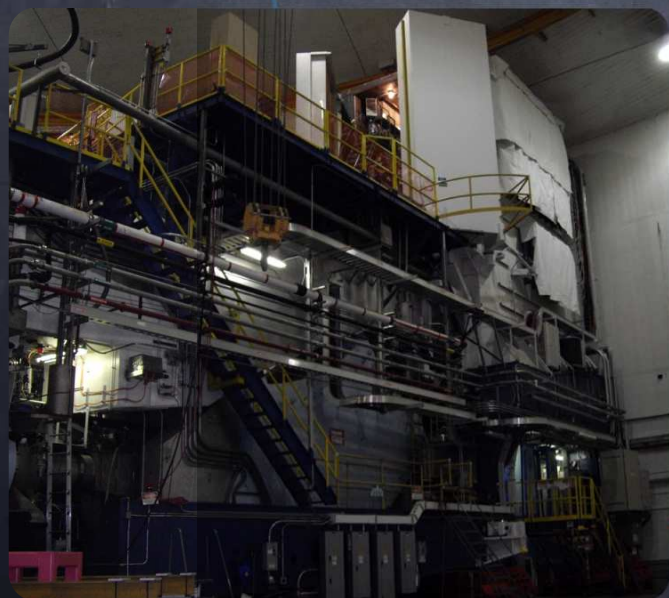
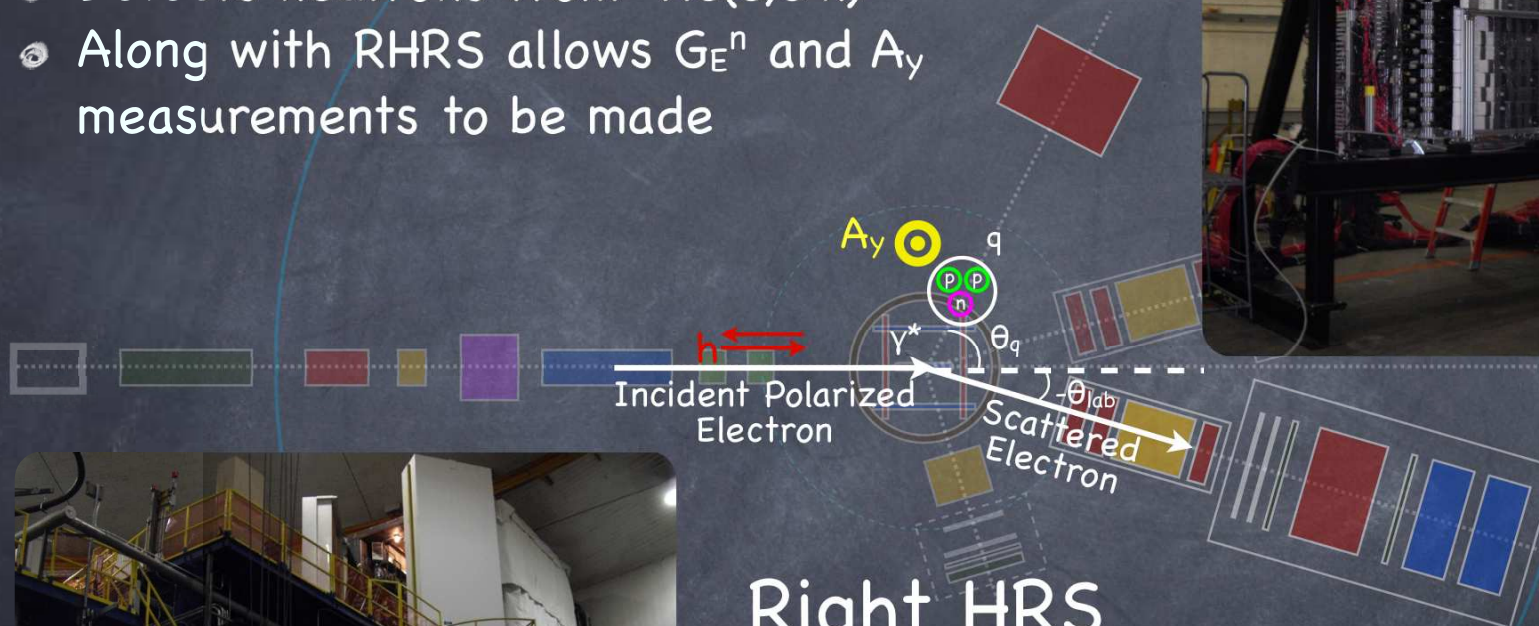
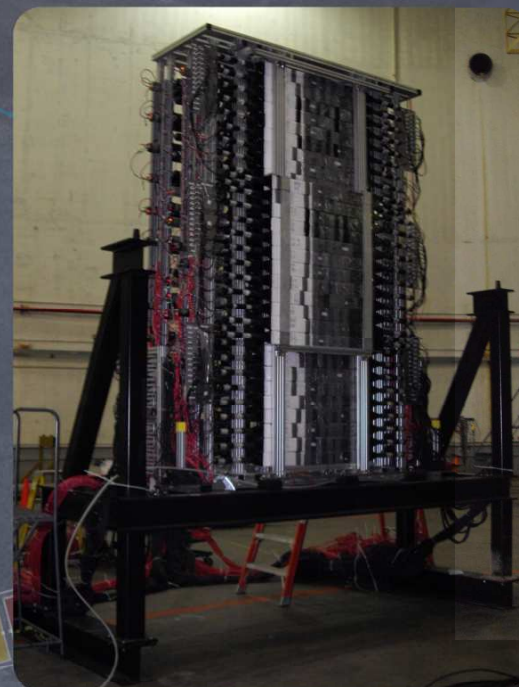


Right HRS

- Detects quasi-elastically scattered electrons from ${}^3\text{He}(e,e'n)$ and ${}^3\text{He}(e,e')$
- With q along beam polarization on ${}^3\text{He}(e,e')$, allows a G_M^n measurement to be made

Hall A Neutron Detector

- Detects neutrons from ${}^3\text{He}(e,e'n)$
- Along with RHRS allows G_E^n and A_y measurements to be made

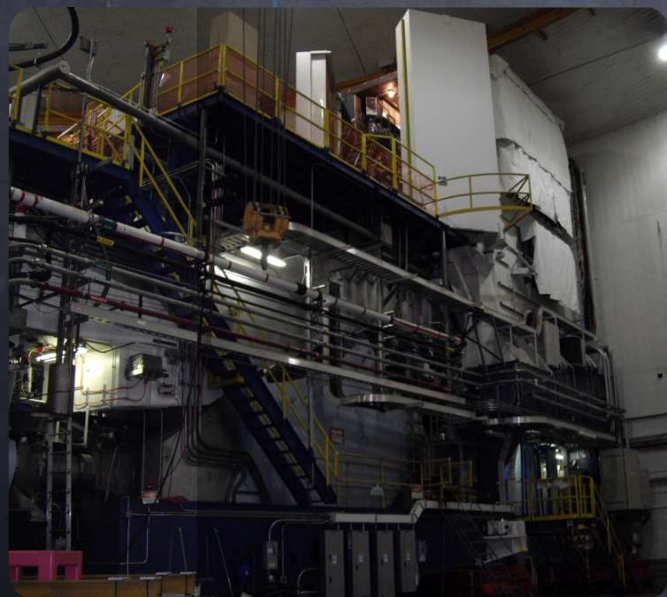
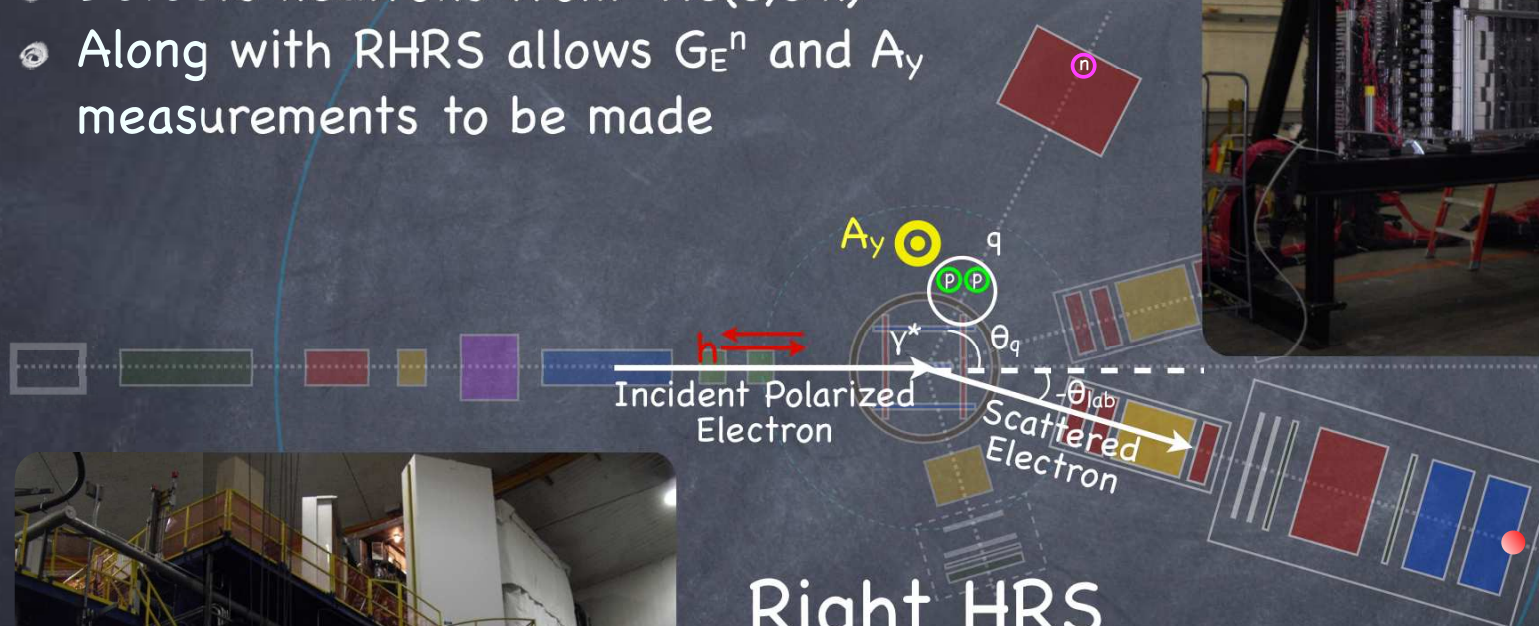
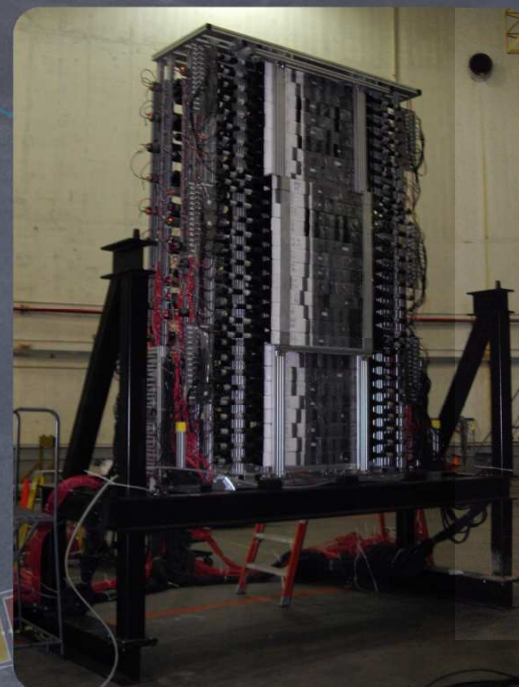


Right HRS

- Detects quasi-elastically scattered electrons from ${}^3\text{He}(e,e'n)$ and ${}^3\text{He}(e,e')$
- With q along beam polarization on ${}^3\text{He}(e,e')$, allows a G_M^n measurement to be made

Hall A Neutron Detector

- Detects neutrons from ${}^3\text{He}(e,e'n)$
- Along with RHRS allows G_E^n and A_y measurements to be made

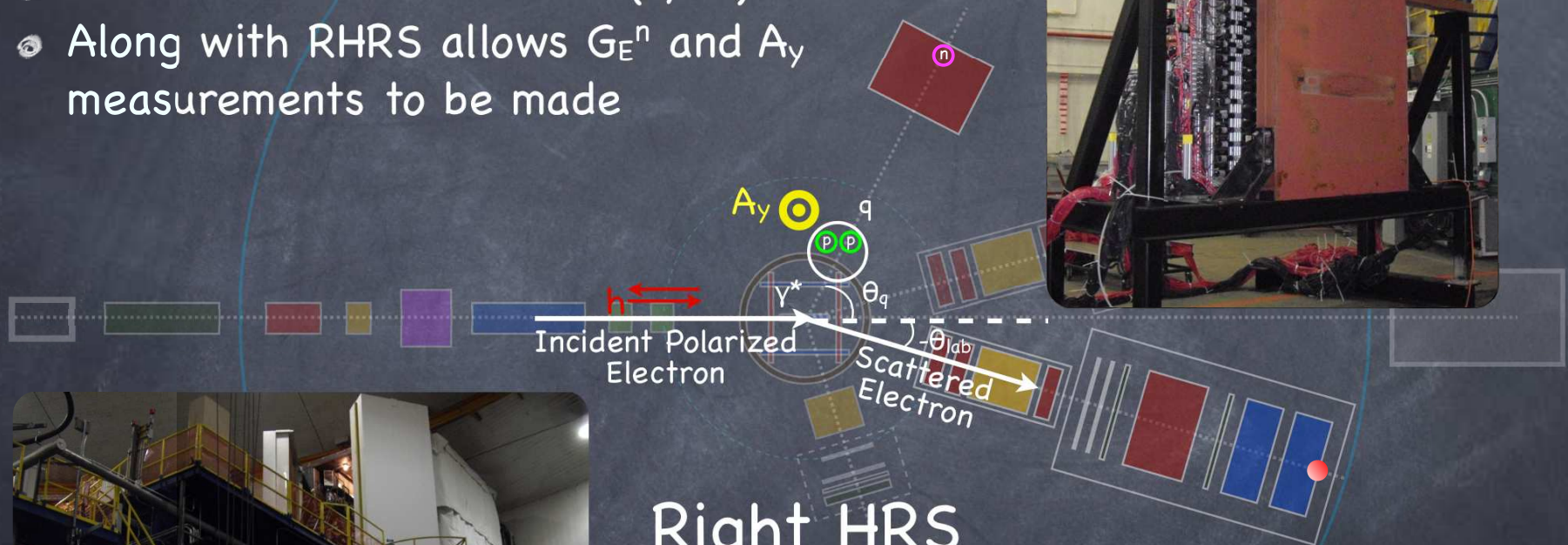
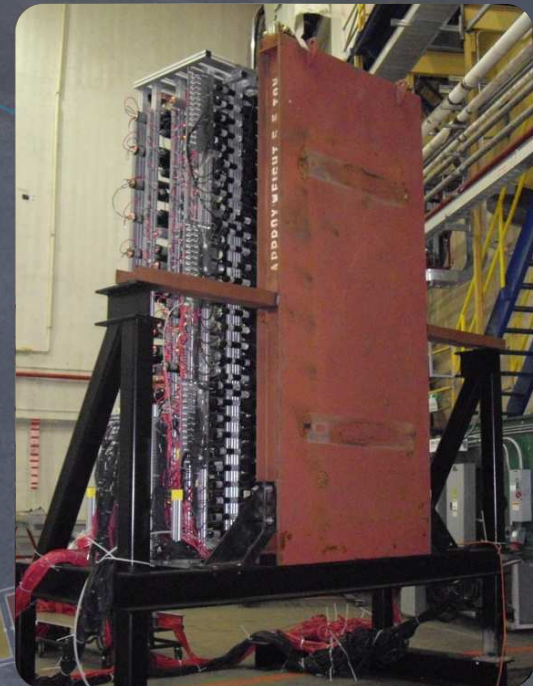


Right HRS

- Detects quasi-elastically scattered electrons from ${}^3\text{He}(e,e'n)$ and ${}^3\text{He}(e,e')$
- With q along beam polarization on ${}^3\text{He}(e,e')$, allows a G_M^n measurement to be made

Hall A Neutron Detector

- Detects neutrons from ${}^3\text{He}(e,e'n)$
- Along with RHRS allows G_E^n and A_y measurements to be made



Right HRS

- Detects quasi-elastically scattered electrons from ${}^3\text{He}(e,e'n)$ and ${}^3\text{He}(e,e')$
- With q along beam polarization on ${}^3\text{He}(e,e')$, allows a G_M^n measurement to be made

$A_y: {}^3\text{He}^\uparrow(e, e'n)$

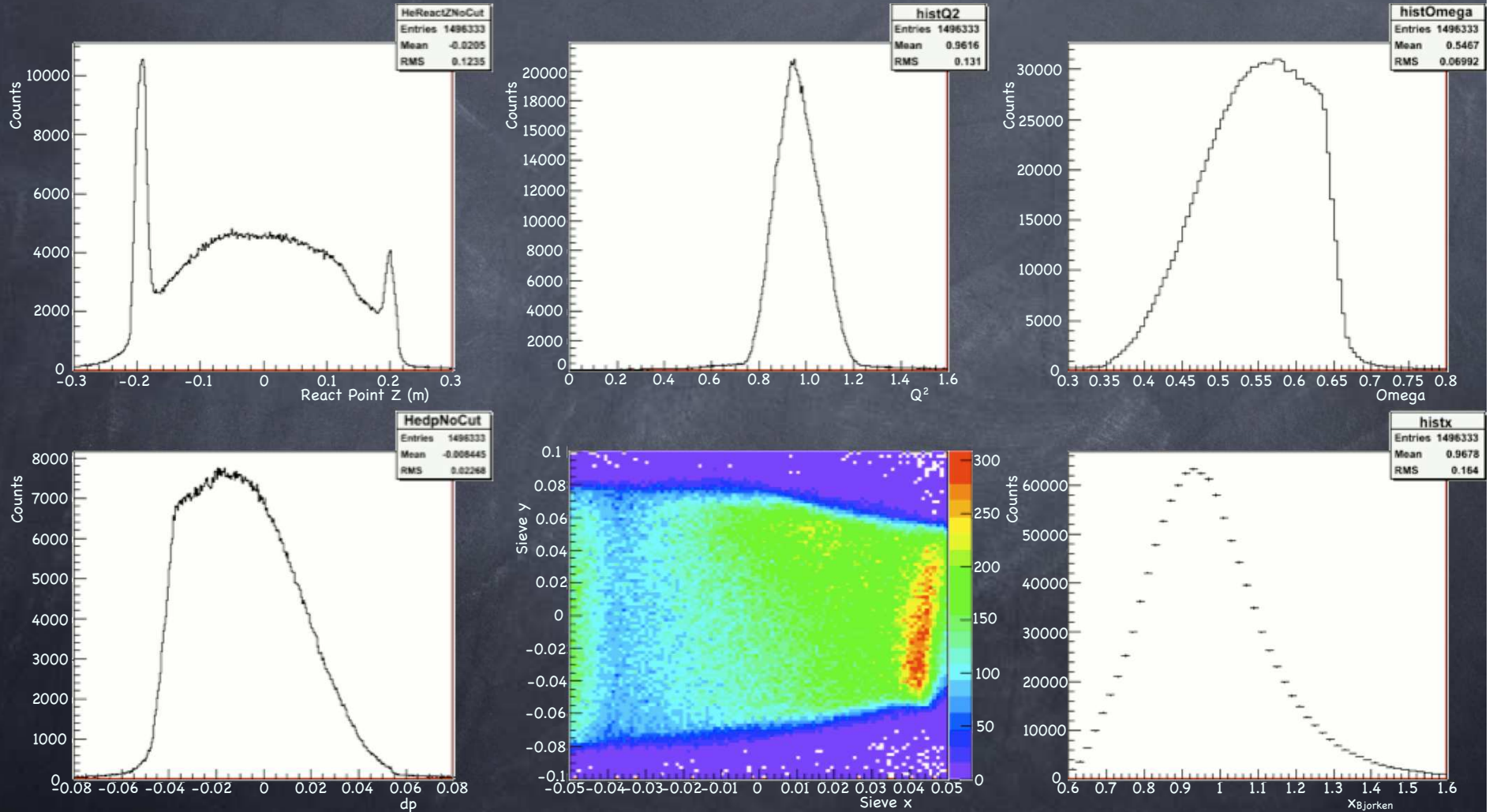
- This experiment, E08-005, ran from April 26th through May 10th in Jefferson Lab's Hall A
- The kinematics taken were:

E_0 [GeV]	E' [GeV]	θ_{lab} [°]	Q^2 [GeV/c] ²	$ q $ [GeV/c]	θ_q [°]
1.25	1.22	17.0	0.13	0.359	71.0
2.43	2.18	17.0	0.46	0.681	62.5
3.61	3.09	17.0	0.98	0.988	54.0

Date	E_0 (GeV)	RHRS (°)	RHRS P_0 (GeV)	LHRS (°)	LHRS P_0 (GeV)	HAND (°)	BigBite (°)
4/26	1.245	-17	1.2205	17	1.2205	71	-74
4/27	1.245	-17	1.1759	17	1.1759	71	-74
4/29	3.605	-17	3.0855	17	3.0855	54	-74
5/6	3.605	-17	3.0855	17	3.0855	62.5	-74
5/8	2.425	-17	2.1813	17	2.1813	62.5	-74

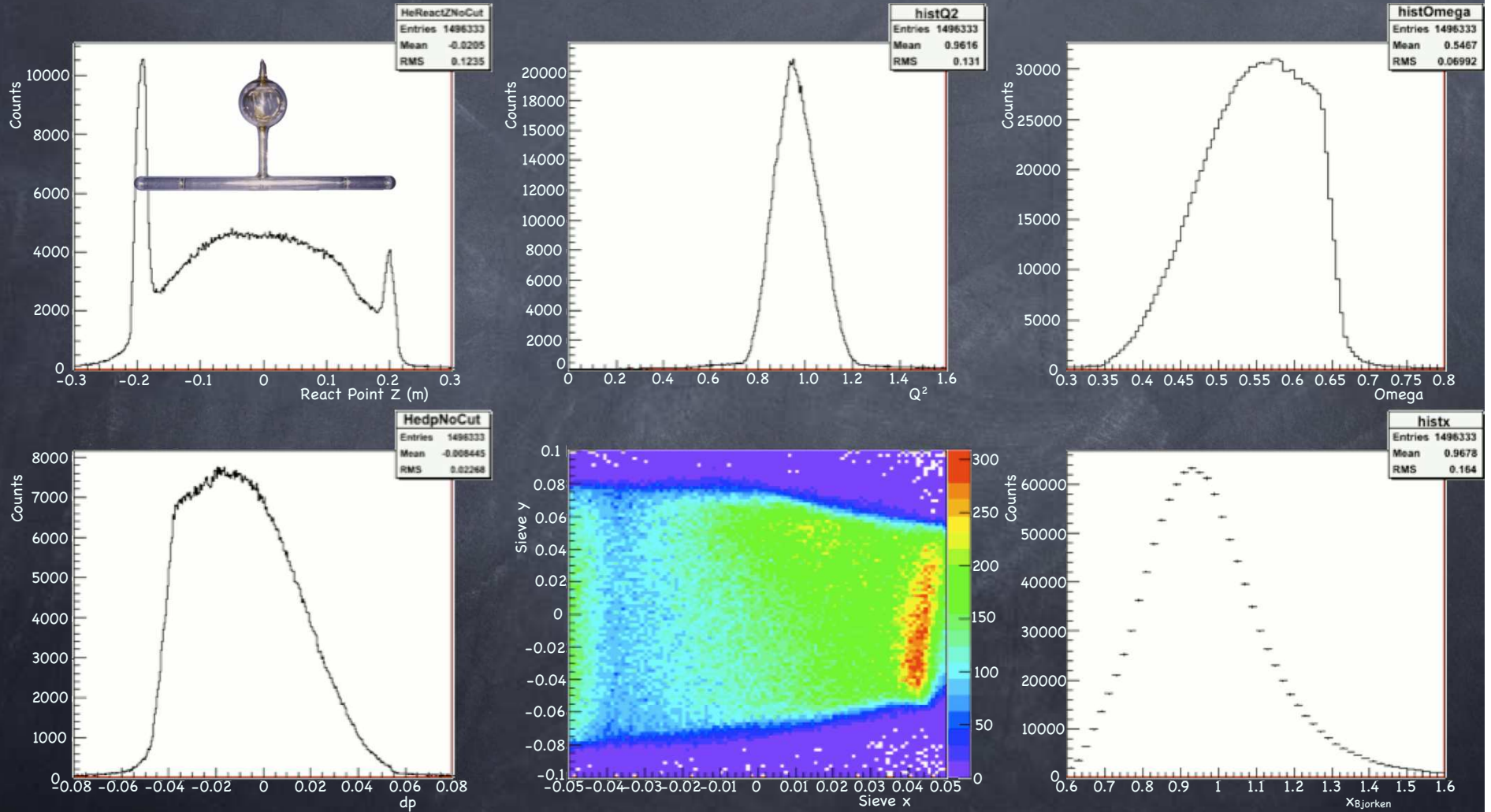
Analysis: Run Check

Typical Run

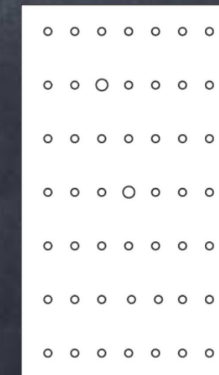
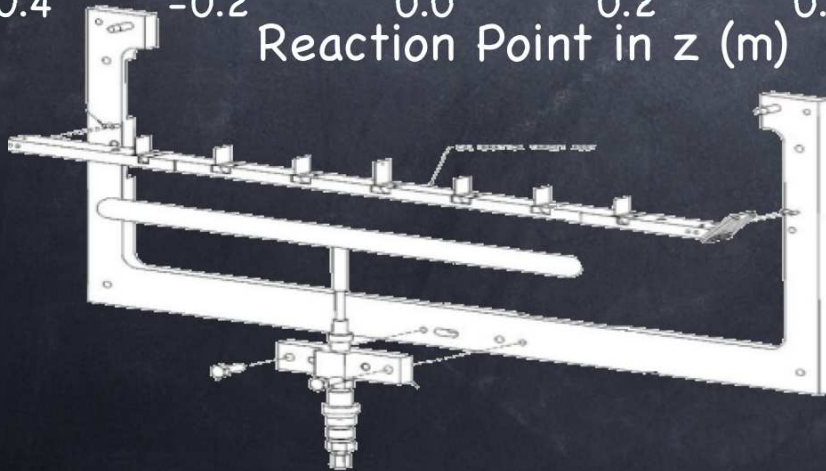
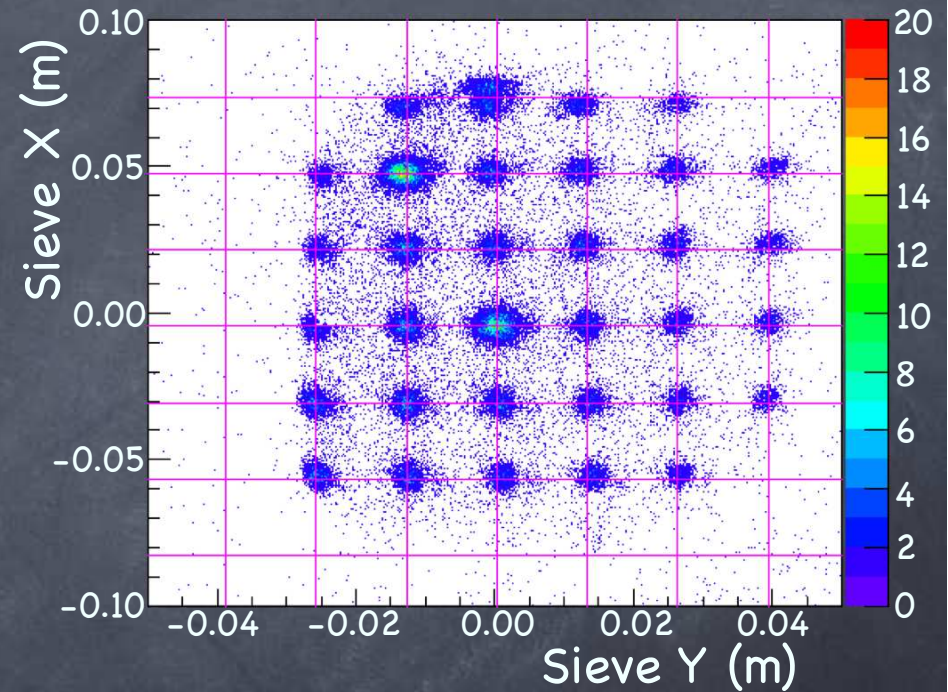
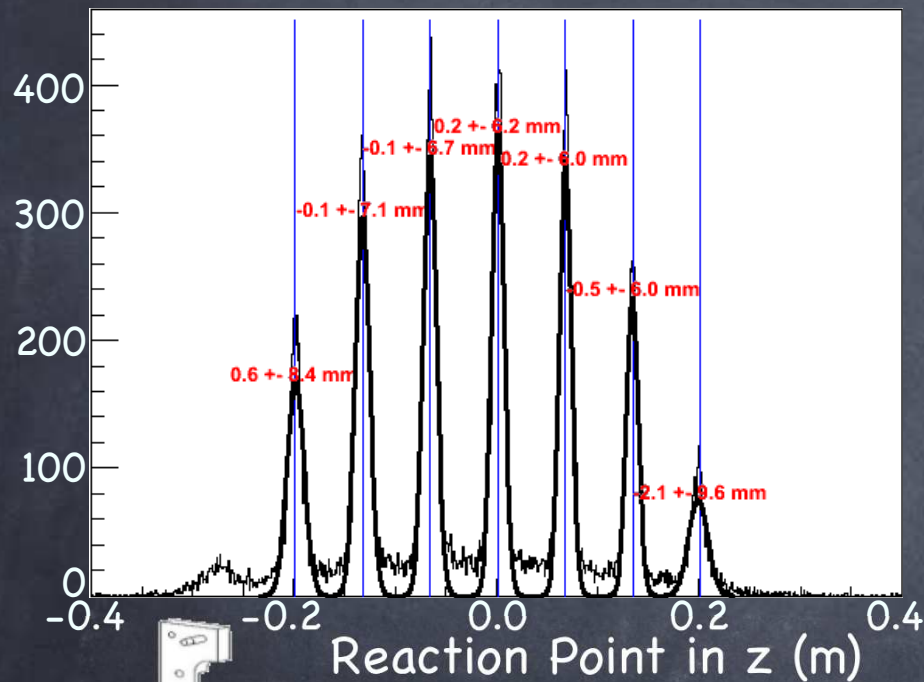


Analysis: Run Check

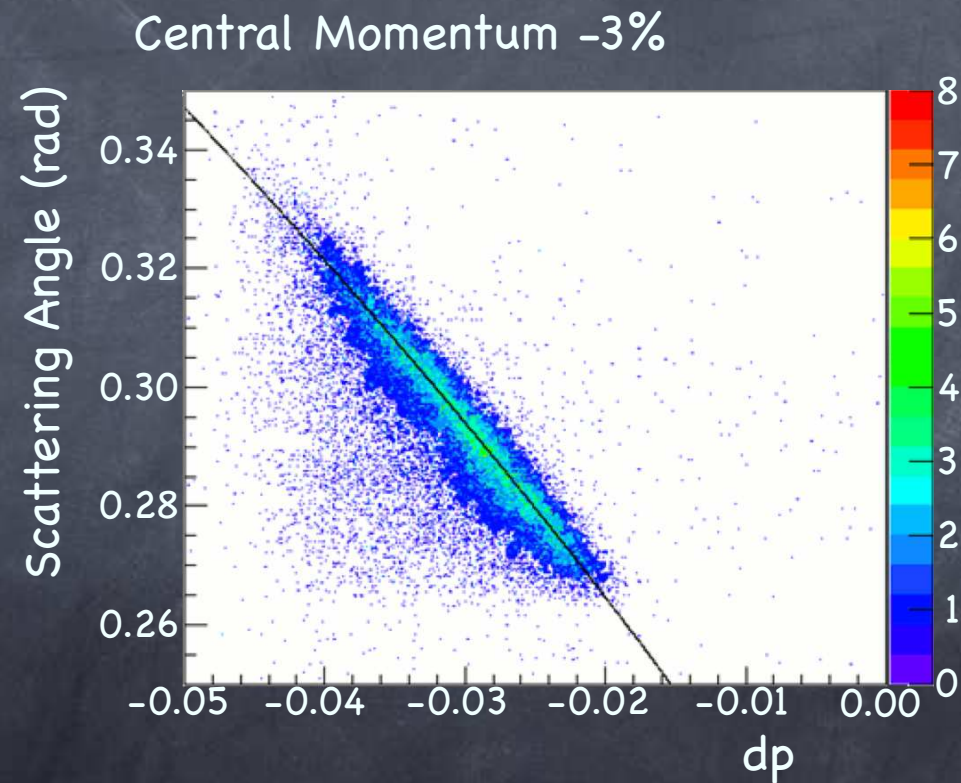
Typical Run



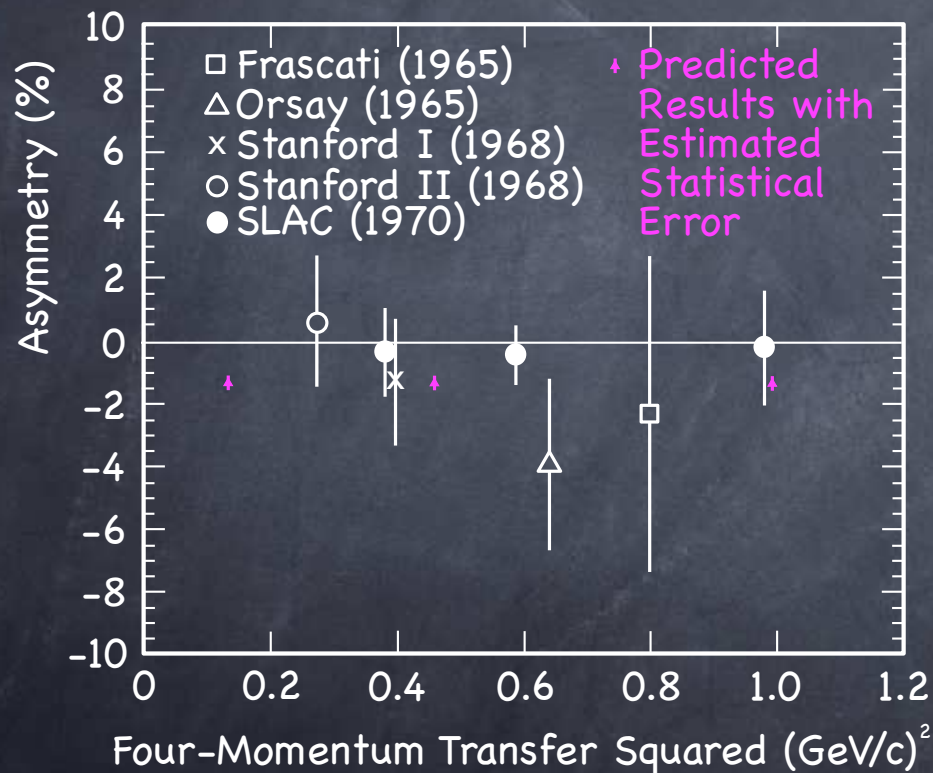
HRS Optics Calibration



HRS Optics Calibration



Estimated Inclusive ${}^3\text{He}(e,e')$ A_y Measurement



- Estimated ${}^3\text{He}(e,e')$ A_y Measurement
- Dominating effect is two-photon exchange
- ${}^3\text{He}(e,e'n)$ A_y is expected to be much larger due to FSI

Summary

- Measuring ${}^3\text{He}(e,e'n) A_y$ at $Q^2=0.1, 0.5,$ and 1.0 (GeV/c)^2 in JLab's Hall A
- Expecting large asymmetry due to FSI
- Analysis is under way
 - HRS calibrations, inclusive ${}^3\text{He}(e,e') A_y$
 - Target density calculations being done
 - Neutron Detector needs calibrated

Thank to the Hall A Quasi-Elastic Family of Experiments

E05-015,
E08-005,
and E05-102

Spokepersons

- T. Averett, College of William and Mary (E05-015, E08-05)
J. P. Chen, Thomas Jefferson National Accelerator Facility (E05-015)
S. Gilad, Massachusetts Institute of Technology (E05-102)
D. Higinbotham, Thomas Jefferson National Accelerator Facility (E05-102, E08-005)
X. Jiang, Rutgers University (E05-015)
W. Korsch, University of Kentucky (E05-102)
B. E. Norum, University of Virginia (E05-102)
S. Širca, University of Ljubljana (E05-102)
V. Sulkosky, Thomas Jefferson National Accelerator Facility (E08-005)

Graduate Students

- G. Jin, University of Virginia
E. Long, Kent State University
M. Mihovilovič, Jožef Stefan Institute
Y. Zhang, Lanzhou University

Run Coordinators

- A. Camsonne, Thomas Jefferson National Accelerator Facility
P. Monaghan, Hampton University
S. Riordan, University of Virginia
B. Sawatzky, Temple University
R. Subedi, University of Virginia
V. Sulkosky, Massachusetts Institute of Technology
Y. Qiang, Duke University
B. Zhao, College of William and Mary

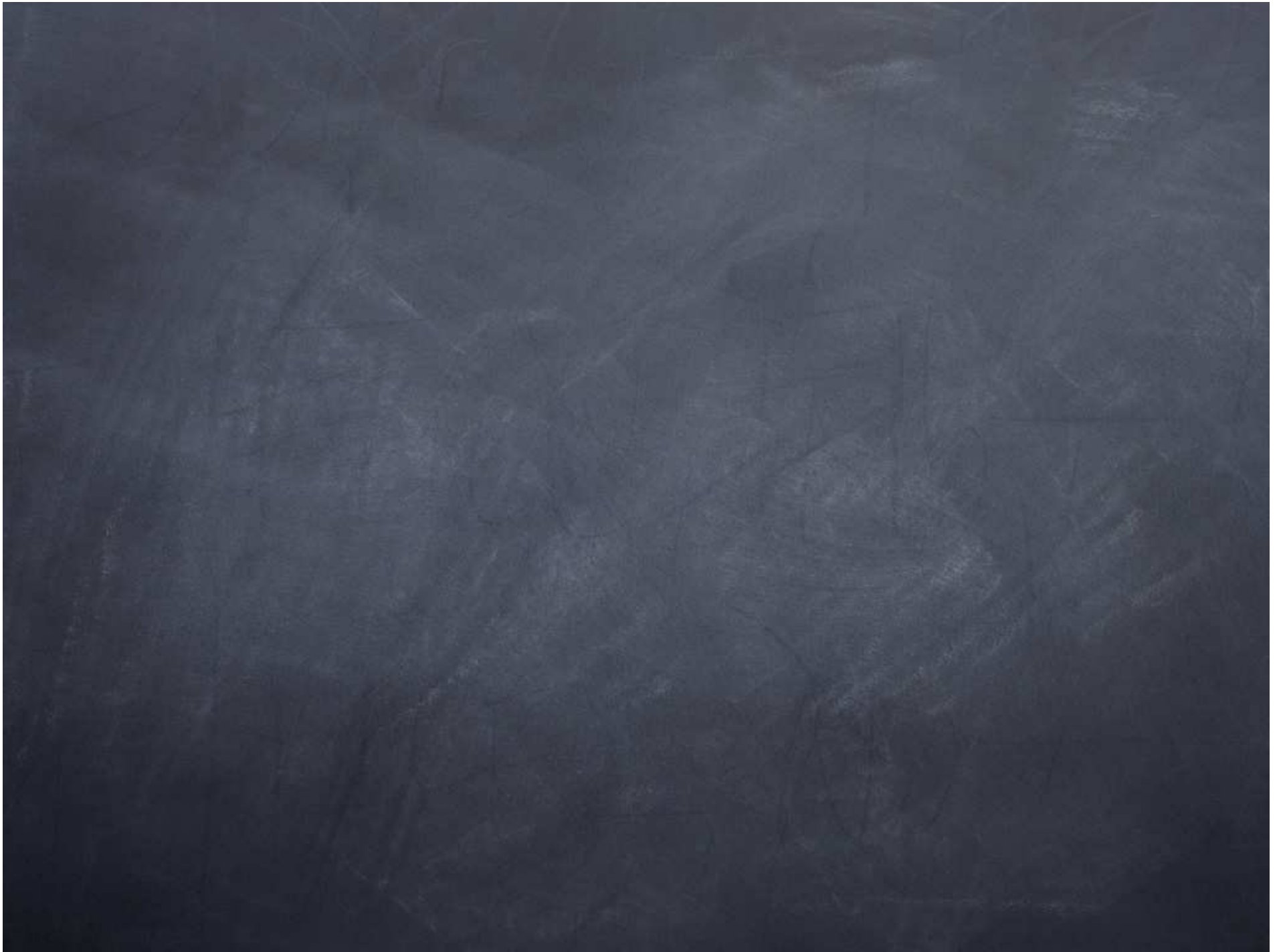
Collaboration

- K. Allada
B. Anderson
J. R. M. Annand
W. Boeglin
P. Bradshaw
M. Canan
C. Chen
C. W. de Jager
R. De Leo
X. Deng
A. Deur
C. Dutta
L. El Fassi
D. Flay
F. Garibaldi
H. Gao

- R. Gilman
S. Golge
O. Hansen
T. Holmstrom
J. Huang
H. Ibrahim
E. Jensen
M. Jones
H. Kang
J. Katich
P. King
J. LeRose
R. Lindgren
H. Lu
W. Luo

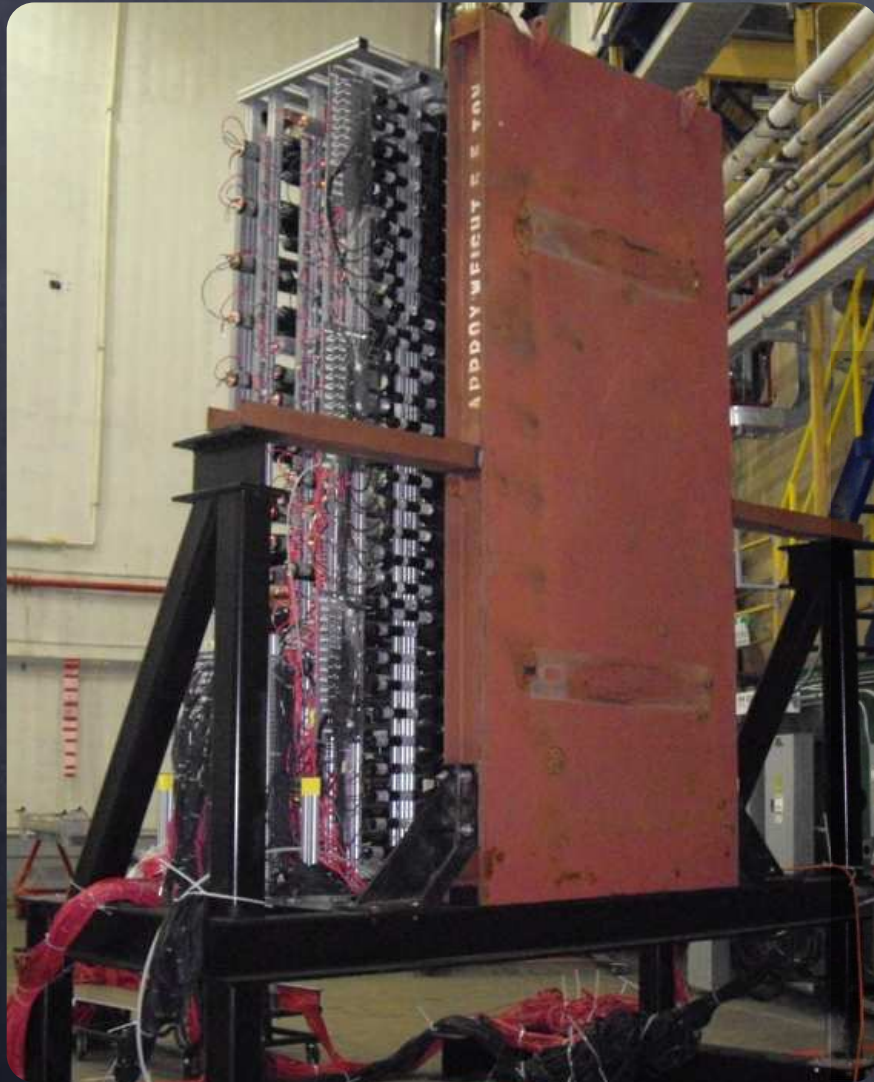
- P. Markowitz
M. Meziane
R. Michaels
B. Moffit
N. Muangma
H. P. Khanal
K. Pan
D. Parno
E. Piasetzky
P. Pradshaw
M. Posik
A. J. R. Puckett
X. Qian
X. Qui
A. Saha

- F. Salvatore
M. Shabestari
A. Shahinyan
B. Shoenrock
J. St. John
A. Tobias
W. Tireman
G. M. Urciuoli
D. Wang
K. Wang
J. Watson
B. Wojtsekhowski
Z. Ye
X. Zhan
X. Zheng
L. Zhu



Extra Slides

Hall A Neutron Detector



- 88 Scintillator + 64 Veto Bars
- ADC and TDC channels recorded for each of 240 PMTs

